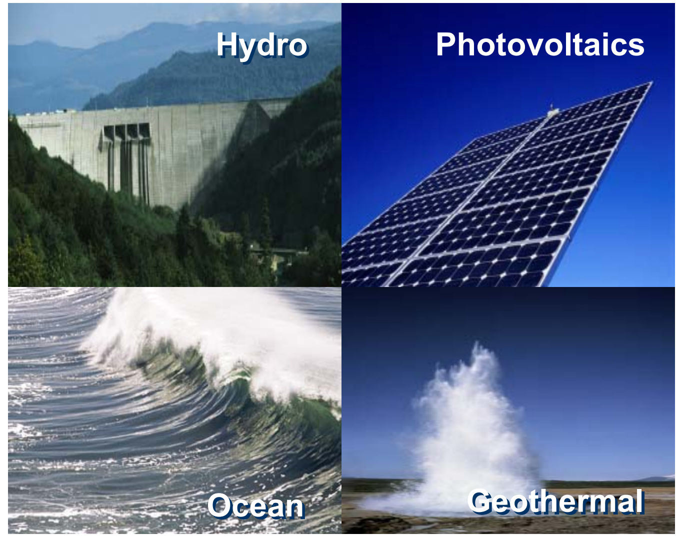
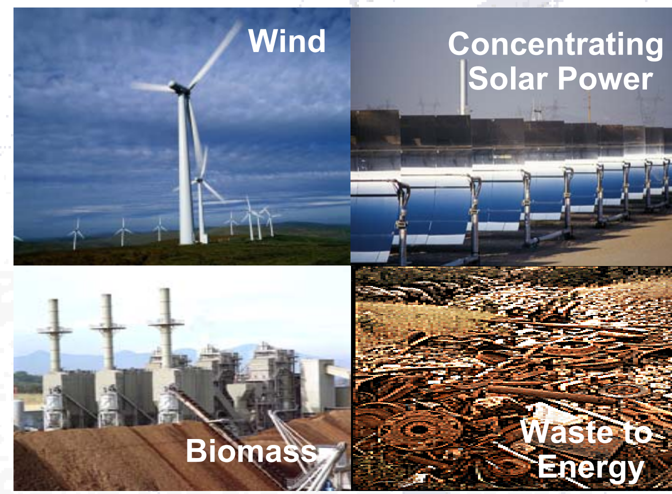
D.T.E. 03-121
NSTAR-SEBANE-1-4 (a)

Rays that Pay: Grid-Connected PV Reduces Electricity Cost by Tapping Old and New Value Drivers



Presentation to:
Boston Area Solar Energy Association
December 12, 2002



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Navigant Consulting (NCI) Staff Have Been Working in the Renewable Energy Field for Over 20 years with Global Project Experience.

Renewable Energy Practice

~ 38 Staff with Technical and Market Expertise: Wind, PV, Concentrating Solar Power, Biomass Power, Geothermal, Hydroelectricity, Ocean Power, Interconnection, Communications, Power Electronics, and Storage

Past Client Examples

Equipment Manufacturers

Schott Glass; First Solar; Philips Lighting; Siemens Solar; United Solar; Akzo-Nobel; MHI; Texas Instruments; GE; Shell Renewables

End-Users

Anheuser Busch; U.S. Navy; Verizon

Developers & Investors

Clipper Wind; Whitney; Constellation Energy; Kidd & Co.; York Research; Atlas Alternative Power; GKN; CIBC; Northern Power Systems; FPL Energy; Arcadia; Ormat

Energy/Utility Companies

Texaco; Phillips Petroleum; BP; LIPA; Salt River Project; E.On; Northern States Power; Osaka Gas; Ontario Hydro; RWE; GPU; NU; Avista; EPRI; Endesa; Texas Independent Energy

Government Agencies/Trade Associations

U.S. DOE; U.S. EPA; UK Carbon Trust; Massachusetts Technology Collaborative; GHP Consortium; UK DTI; California Energy Commission; U.S. AID; EEI; ECN

PV Economics

The PV Vision of the 70s: Low Cost, Plentiful and Clean Energy that Can Displace Utility Power in the Near Future…

"The objective of the Low-Cost Silicon Array Project of the U.S. Energy Research and Development Administration is to produce photovoltaics for less than $500 per peak kilowatt, and to be annually producing more than 500 megawatts by 1985… A general consensus appears to be developing among the participants that the goals are reachable and may even be far too modest."

--Denis Hayes

Rays of Hope – The Transition to a Post-Petroleum World
(1977)

PV is Widely Viewed as Significantly More Expensive Than Conventional Utility Service.

"PV-generated electricity is still considerably more expensive than conventional utility-supplied electricity. The cost of PV electricity is about 25 cents per kilowatt-hour, roughly twice the retail price that most New York residents pay for electricity from the utility grid."

New York Consumer Guide to Buying a Solar Electric System

PV Buyers are Presumed to Have Non-Financial Motives, but Navigant Consulting's Analysis Shows an Economic Benefit for Installing PV.

Current Purchasing Motives for PV

- Environmental and sustainability concerns
- Desire for greater self-reliance
- Allure of being an early adopter of a new, exciting, technology that is on display for all to see
- Anti-corporate political statement in the post-Enron era?

CNN.com

Solar homes: Not just for hippies anymore

Navigant Consulting, Inc.

PVs May Soon be Regarded as the "Rays that Pay!"

- Old and new sources of value make PV cost effective compared to full requirements utility service
- Annual cost savings of \$100 - \$250 per year for typical residential customers in our NSTAR (Boston) case study
- Net present value of electricity cost over 20 years is cut by 37% with a 3kW PV installation relative to continued full-requirements utility service
- Levelized cost of energy from PV is 9.85¢ per kWh; avoided utility rates are up to three times higher!

How Can Residential PV be Cost Effective Today?

Basic Ingredients:

- Net metering
- Low, tax-deductible interest rates
- Generous state buy-down programs
- State tax credits; proposed federal tax credit
- PV exemption from sales and property tax
- GIS Certificate (aka green tag) revenues
- Eligibility for emission allowance set-aside programs
- Existing optional time-of-use rates by local utilities

How Can Levelized Cost of PV be Less Than 10¢ per kWh?

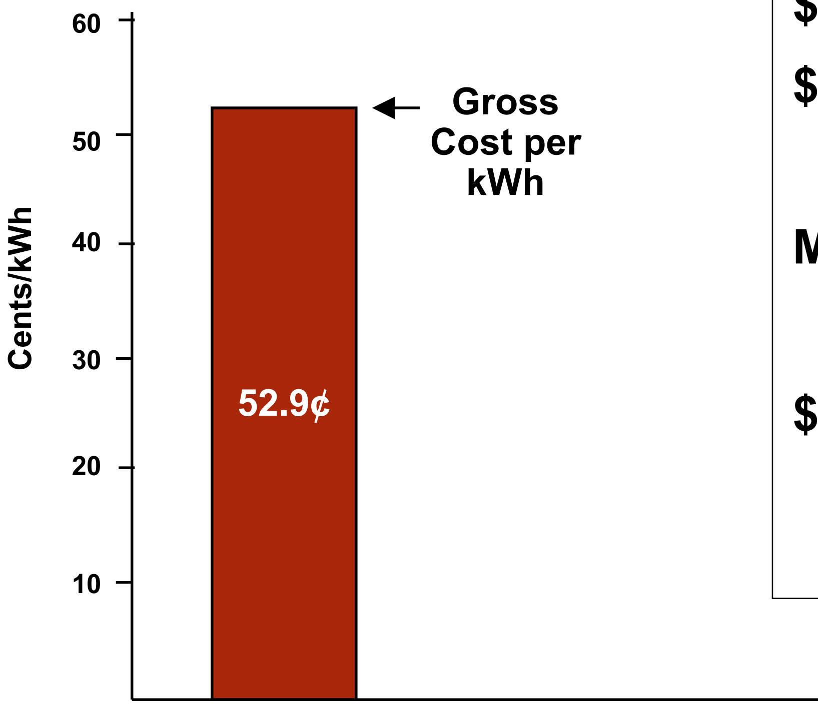
Basic Assumptions:

- Installation Site: Boston, MA
- Installed Cost: $9,000 per kW, plus new inverter in year 12
- Lifespan of PV: 20 Years
- Source of Financing: 20 Year mortgage (home equity) @ 6%
- Annual Capacity Factor: 17%
- System Capacity: 3 kW
- Annual Production: 4468 kWh
- Roof Area Needed: 300-600 sq ft., depending on module

NSTAR Case Study

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

Levelized PV Cost



$27,500 mortgage @ 6% over 20 years =

$197.00 monthly loan payment

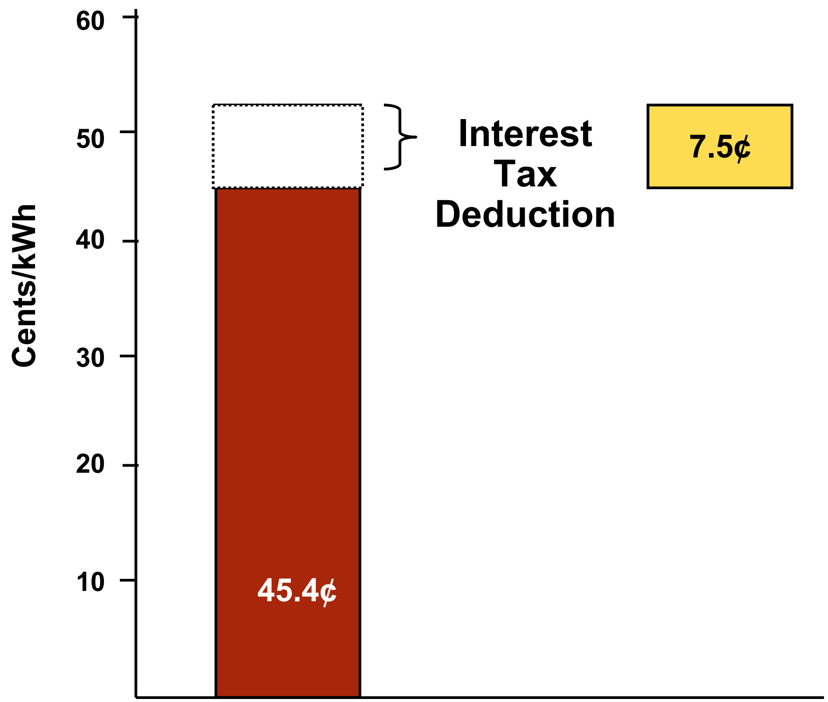
Monthly average output = 372 kWh

$197 / 372 kWh = 52.9¢ per kWh

NSTAR Case Study

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

Levelized PV Cost

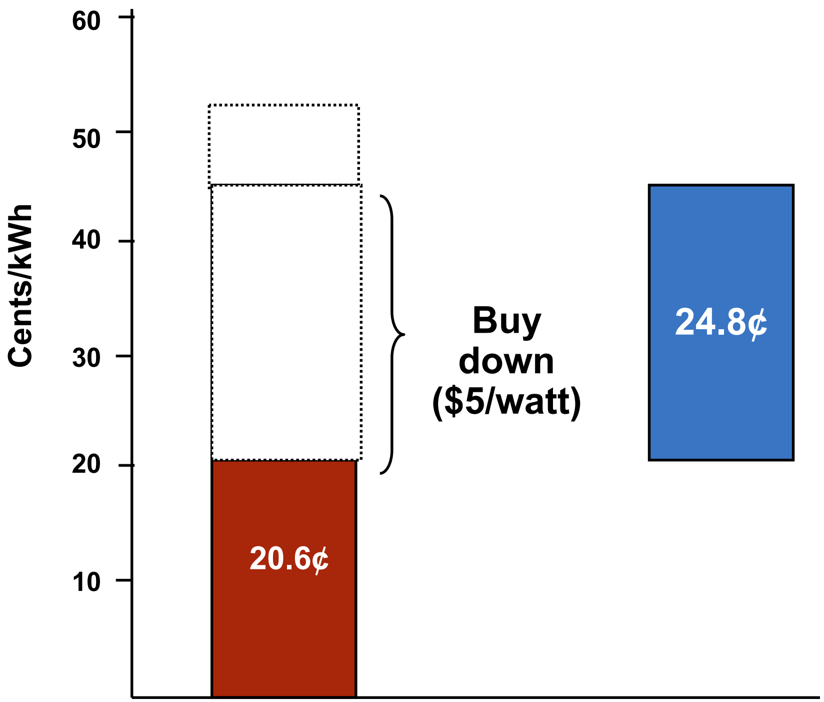


#1 Tax Deductible Mortgage Interest

- Determine after-tax loan rate
- In MA, mortgage interest is deductible on federal taxes only
- Marginal federal tax rate for joint filers earning between $109,250 and $166,500 is 30.5%
- After-tax loan rate is (1-tax rate) x Interest Rate = 4.17%.
- Cost per kWh @ 4.17% = 45.4¢
- Cost savings = 7.5¢ per kWh

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

Levelized PV Cost



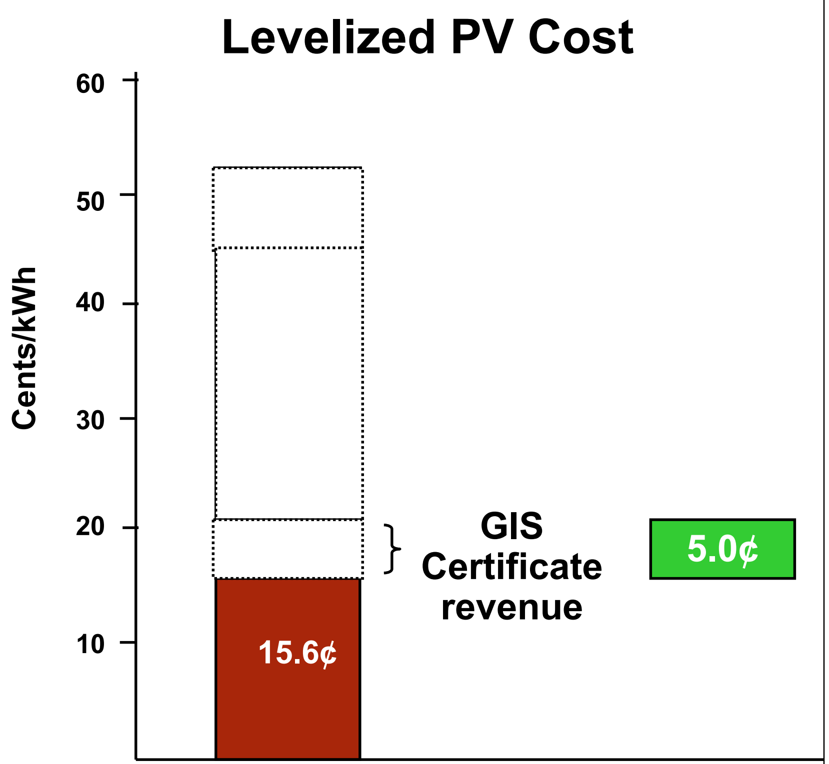
#2: State Buy-Down Program

- MA is providing buy-down program of $5,000 per kW
- Reduced loan payment @ 4.17% = $92.25 / month
- $92.25/ 372 kWh = Cost savings of 24.8¢ per kWh

NSTAR Case Study

Example: NSTAR (Boston) Residential PV System

(assumes $9,000/kW gross installed price rolled into mortgage)



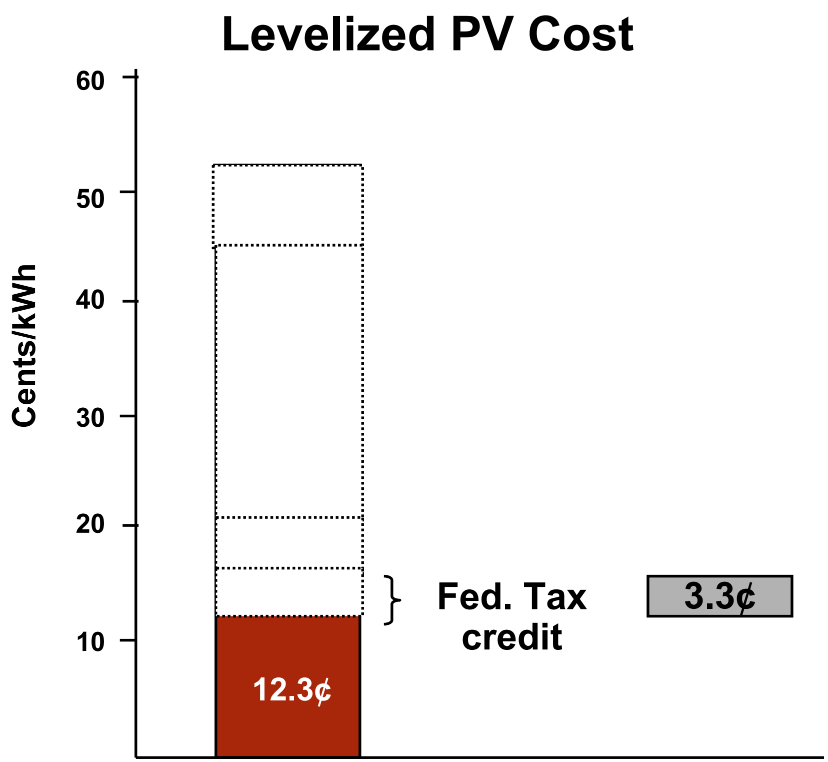
#3: GIS Certificate Revenue

- Electronic registry enables trading of generation attribute "certificates" (aka green tags) for RPS, disclosure, emission rules and green marketing
- GIS allows net-metered renewables to create certificates, which can be sold <u>without</u> sale of the power
- MA RPS rules establish a ceiling price of 5¢ per kWh for RPS-eligible certificates. Recent trades have been in the 5¢ range
- GIS Revenue = 5¢ per kWh

NSTAR Case Study

Example: NSTAR (Boston) Residential PV System

(assumes $9,000/kW gross installed price rolled into mortgage)

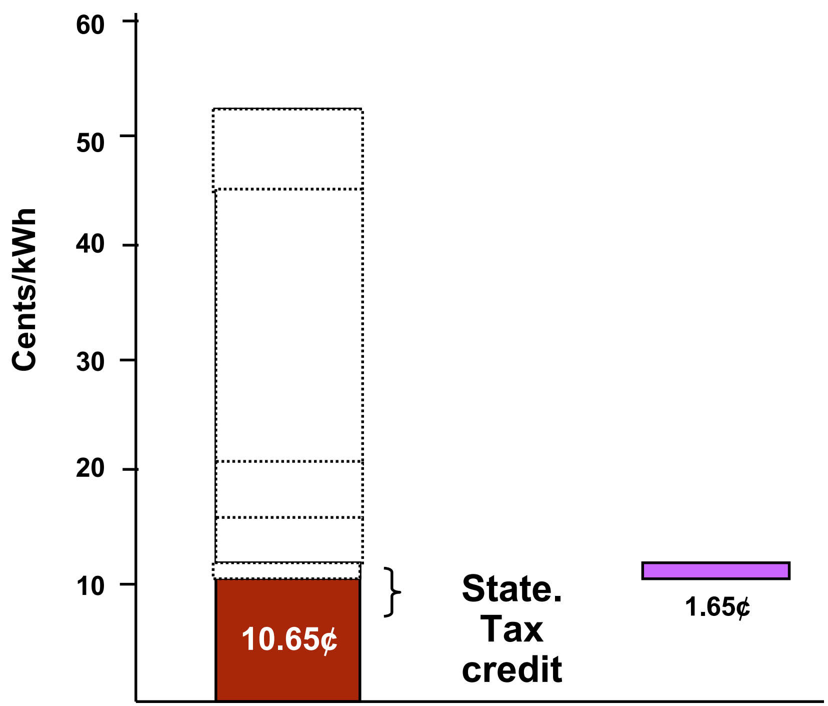


#4: $2,000 Federal Tax Credit (pending in National Energy Bill)

- 15% tax credit (up to $2,000) for rooftop PV systems
- Would not exclude buy-down grants from eligible costs
- Avoided loan payment = $12.30 / month
- Cost savings of 3.3¢ per kWh

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

Levelized PV Cost

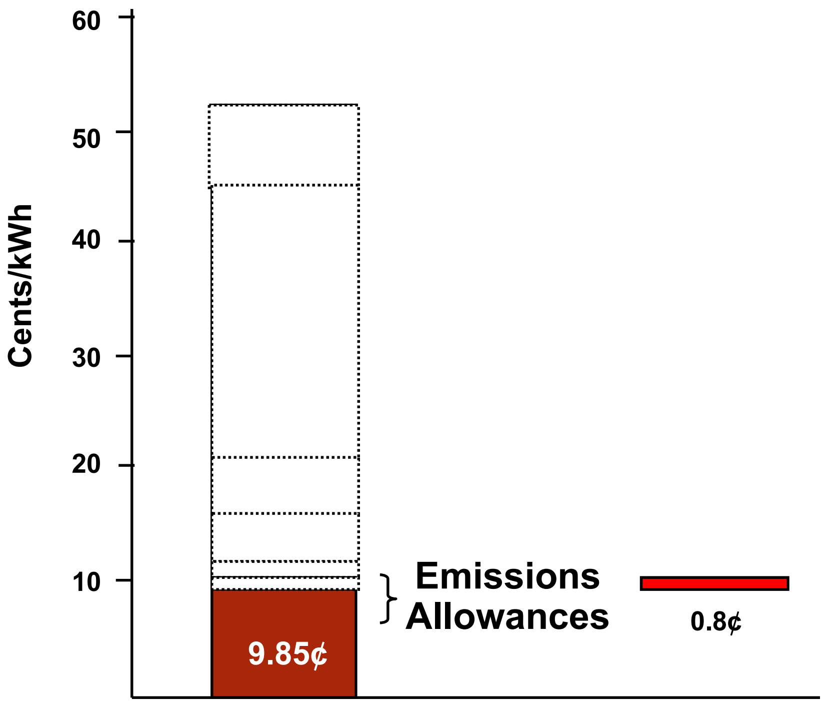


#5: Existing $1,000 MA Tax Credit

- 15% tax credit (up to $1000) for rooftop PV systems
- Would not exclude buy-down grants from eligible costs
- Avoided loan payment = $6.15 / month
- Cost savings of 1.65¢ per kWh

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

Levelized PV Cost



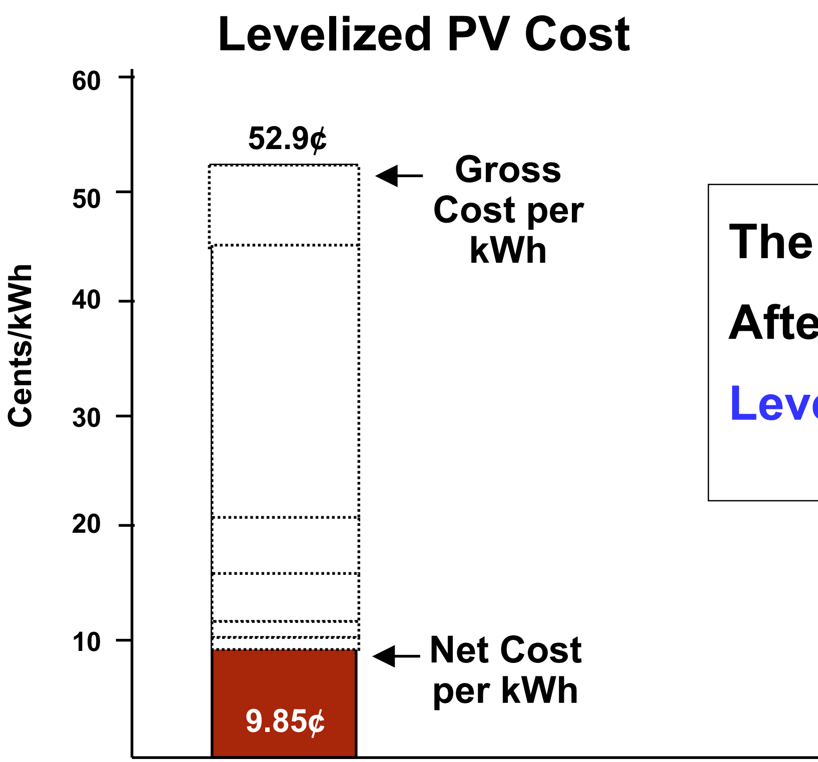
#6: Emission Allowance Set-Aside

- MA DEP will allocate 5% of NOx allowances for new renewables and energy efficiency projects
- Awards will be set at 1.5 lbs NOx per MWh. NOx allowances currently trading at $5,000 per ton.
- DEP expected to award CO_2 emission reduction credits (ERCs) for new renewable production. $5.00 per ton CO_2 ERCs expected
- Emission allowance revenue = 0.8¢ per kWh

NSTAR Case Study

Navigant CONSULTING, INC.

Example: NSTAR (Boston) Residential PV System
(assumes $9,000/kW gross installed price rolled into mortgage)

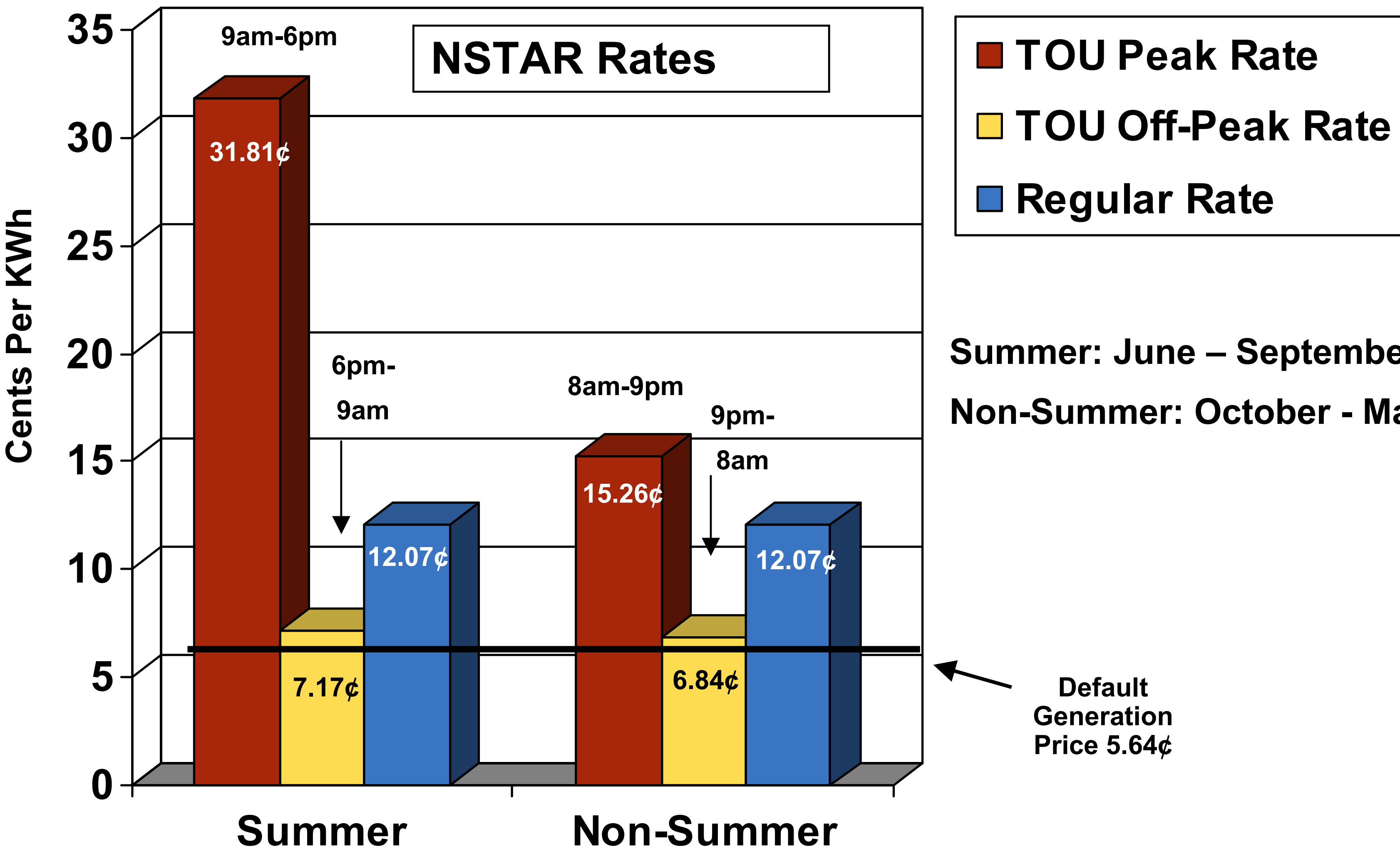


The Bottom Line:

After all credits, revenues and buy-downs,

Levelized Net Cost of PV = 9.85¢ per kWh!

How Much Electricity Cost Does the PV System Avoid? It Depends on the Rate Structure



Summer: June – September

Non-Summer: October - May

Optional Time-of-Use Rate Offers Substantially Lower Cost for Post-PV Utility Electricity Consumption

Why?

- **3kW PV system completely eliminates net utility consumption during summer peak hours and 90% of peak consumption during non-summer period.**
- **Remaining utility consumption is largely confined to off-peak hours that cost much less than charges on standard (non-TOU) residential rates.**

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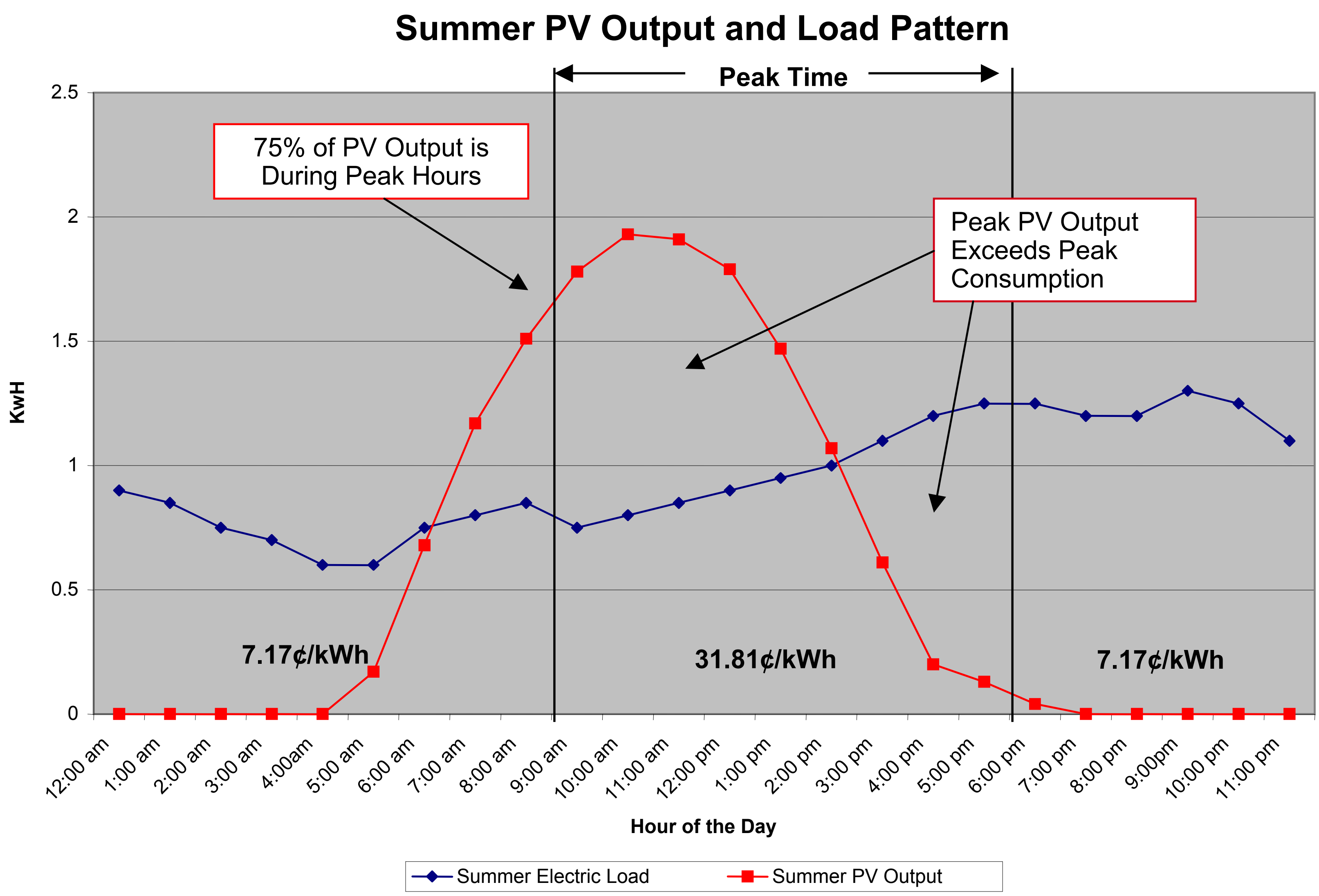
How Much Utility Electricity Use and Cost Does the PV System Avoid?

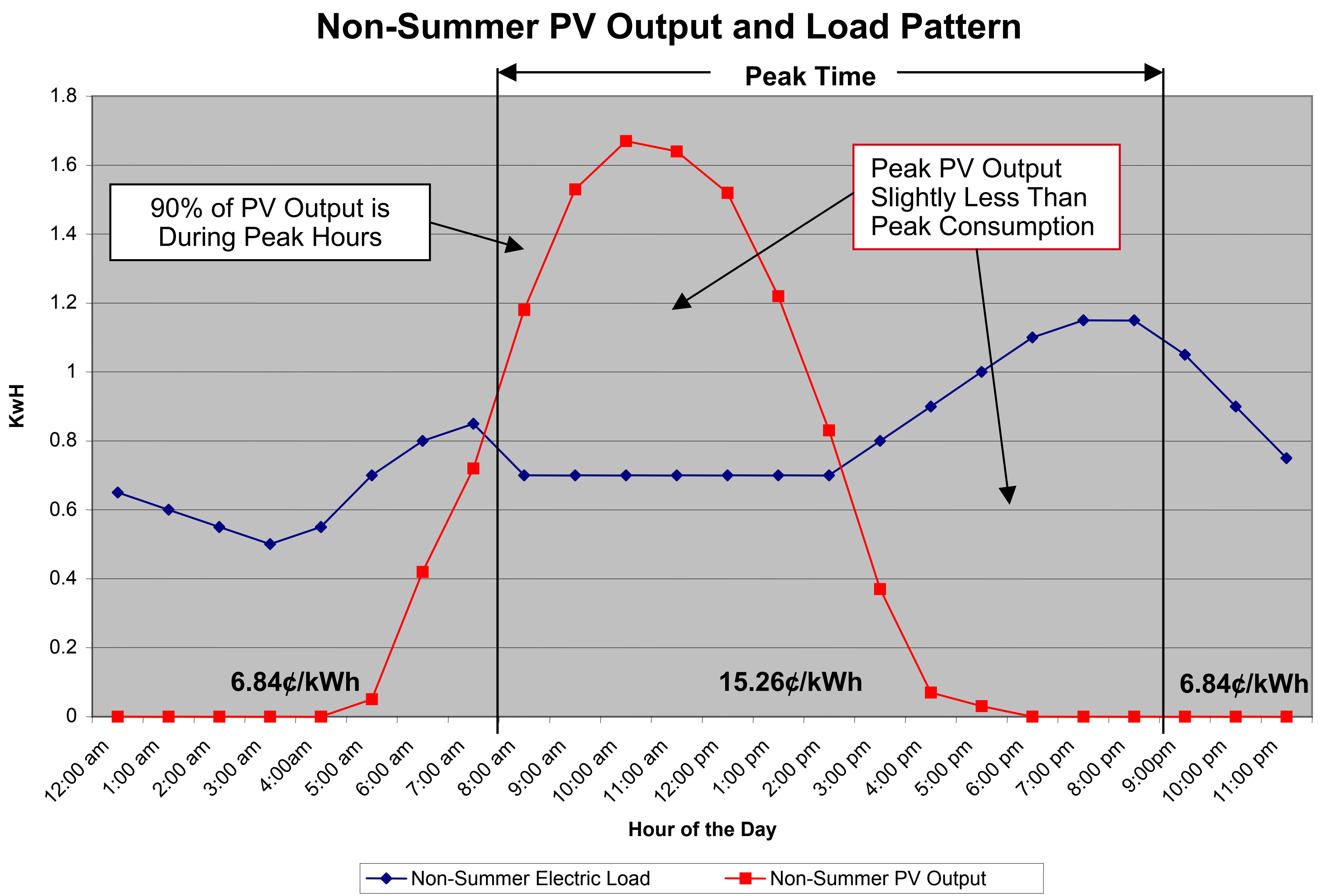
- Typical New England non-electric heat customer (with room A/C units) consumes 7,387 kWh per year
- 3 kW PV system generates 4,468 kWh per year
- Post-PV average annual consumption from utility is 2,919 kWh or 39.5% of prior utility consumption
- Remaining cost for utility service will depend on customer's rate class

NSTAR Case Study

24-Hour Load Curve, PV Profile for 3kW System & NSTAR TOU Rate



24-Hour Load Curve, PV Profile for 3kW System & NSTAR TOU Rate



Bottom Line Cost Comparisons :

Full Requirements Utility Service	$969 per year
PV with Regular Utility Rate	$871 per year
PV with TOU Rate	$723 per year

- PV with the TOU rate produces a total financial benefit of $245 per year compared to full requirements utility service. $148 of this is the result of the TOU rate.

- Cost savings begin Day 1 with the PV investment!
- Payback time = 0

20-Year Net Present Value Analysis: There's PV in NPV!

Full Requirements Utility Service:	**$16,259**
3 kW PV with TOU Rate	**$10,300**
3 kW PV with Reg. Rate	**$12,786**

- **PV Scenarios range from 63% to 79% of the NPV costs for full requirements utility service**
- **PV is a great investment! But, as always, there are some risks to consider….**

PV Risk Issues

#1 PV Equipment Longevity and Performance. Will there be significant maintenance or replacement expenses?

- Several manufacturers guarantee PV performance for up to 20 years. Inverters and other electronics probably will not last as long, and are usually guaranteed for 5-10 years.
- A replacement inverter (which costs about 80¢ per Watt today) is assumed at year 12 and is expected to decrease to 30¢ per Watt in 2014.

Additional Considerations

PV Risk Issues

#2 Will GIS certificate value be sustained over the long term? How can I access this value?

- Certificates are the compliance currency of RPS rules, emissions performance standards, and green power marketing. RPS is the dominant driver of value and is expected to last at least 10 years, and most likely at least through 2020 during which a proposed federal RPS would operate.
- Aggregators/administrators are gearing up to provide turnkey services to net-metered renewable generators who want to easily access GIS value in the market.

Additional Considerations

PV Risk Issues

#3 Will utility rates change in ways that could reduce the value of the PV systems? (e.g. imposition of demand charges, partial exit fees, elimination of TOU, etc.)

- If utilities face large revenue erosion from net-metering, these issues will come up in rate cases.
- Policymakers need to send clear messages about the long-term rules that help establish investment certainty

Additional Considerations

PV Risk Issues

#4 Can I count on net metering provisions to remain in effect over the life of my PV system?

- **Some jurisdictions have specified a ceiling for the amount of net metered capacity as a percent of system load, at which time net metering is discontinued. Again, policymakers need to provide investment certainty.**
- **Grandfathering of net-metered customers (or elimination of the ceilings) would be useful.**

PV Risk Issues

#5 If I sell my home before the end of the PVs system's useful life will I recover my investment in the sales price?

- **Prospective buyers need to understand the intrinsic value of PV to incorporate it in a home valuation. This is a key educational challenge for policy makers.**
- **Financing mechanisms that allow the current homeowner to pass on the PV financing obligation to the next homeowner can alleviate the risk of stranded investment. "Pay-As-You-Save" utility and municipal loan programs now exist in which long-term homeowner loans can carry over to new owners and need not be retired at time of property sale.**

PV Risk Issues

#6 If I invest in PV today, will my decision prove unwise if better equipment hits the market in a few years?

- **Because of the immediate cost savings potential for existing PV equipment, improved PV systems will have to be significantly better to negate the benefit of the earlier savings. Improvements in PV are likely, but probably not of the magnitude to justify delay.**
- **Buy-down programs are likely to be scaled down as equipment performance improves.**

Additional Considerations

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PV Risk Issues

#7 Are there other hidden costs of owning a PV system?

- System could be subject to sales and property taxes. Both of these have been waived under Massachusetts tax rules for PV. Other states have similar provisions.
- Homeowner's insurance costs may increase due to the PV. If the equipment must be listed separately for coverage, there will probably be an additional premium.
- Other than inverter replacement (in year 12) ongoing costs are minimal to keep the panels clean and free of debris.

Recommendations to Policymakers

- Education about PV value is critical to develop a broad market among financially minded consumers.
- Buy-downs are still needed, but can be reduced over time as the true economic value of PV is recognized in the market.
- State and federal policymakers need to provide PV investment certainty with long-term commitment to TOU rates, net metering, RPS, tax policies, and other key building blocks.
- PAYS (Pay-As-You-Save) financing models are an excellent way to reduce stranded investment risk and should be more widely available.
- Small performance improvements will leverage big economic payoffs.

For More Information…

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